THE DENVER ENGINEERING WORKS COMPANY

SHEPARD AND SEARING

BULLETIN No. 1046 **OCTOBER 1, 1910**

CRUSHING ROLLS CONVERTIBLE 1910 TYPE

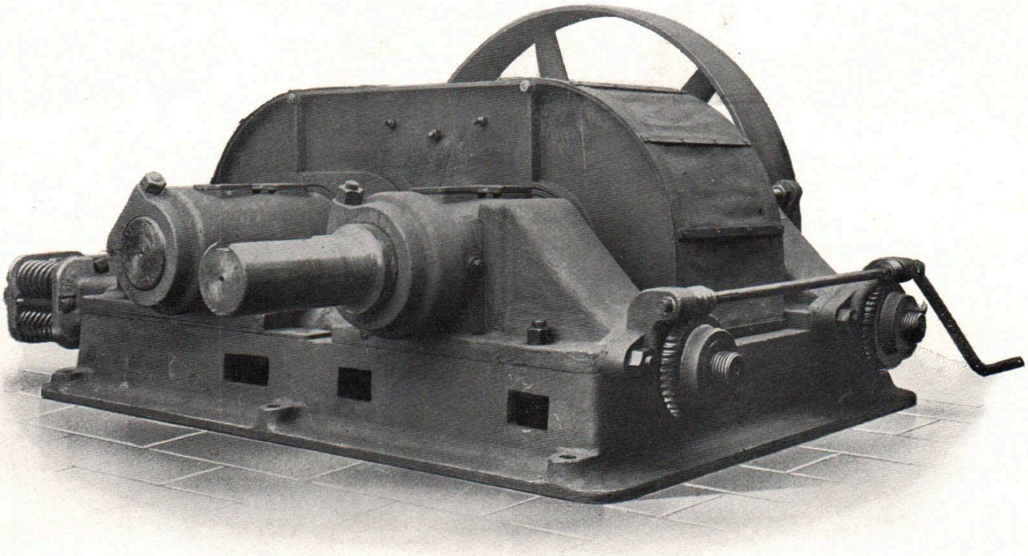


FIG. 853—36X16 ROLLS—WITH SPRINGS

CRUSHING ROLLS
CONVERTIBLE—1910 TYPE

These Rolls are of recent design, from which have been eliminated all the weak points made known during fifteen years' experience in manufacturing, and in which are all the improvements suggested by experienced mill men and metallurgical engineers.

CHIEF POINTS OF SUPERIORITY:

All adjustments can be made without stopping Rolls.

Distance between Roll Shells adjusted by worm gear and crank.

Lateral Adjustment of Shaft.

Swivel bearings, self-aligning, no cramping of shaft in bearing when one side of Rolls opens more than the other.

Bottom of frame, as well as top of frame, machine finished.

Bronze Bushings. Grit Proof Bearings.

Journal boxes interchangeable. Shafts ditto; and also with Rigid or Spring type.

Very large shafts and journal boxes, insuring longer life and a higher speed than with the ordinary Rolls.

Renewable wearing plates under sliding pedestals.

Shafts removed without disturbing tension bars or springs.

All large nuts are clamp nuts, small ones self-locking.

Rigid and Spring Roll parts interchangeable and requiring therefore only one set of spare parts.

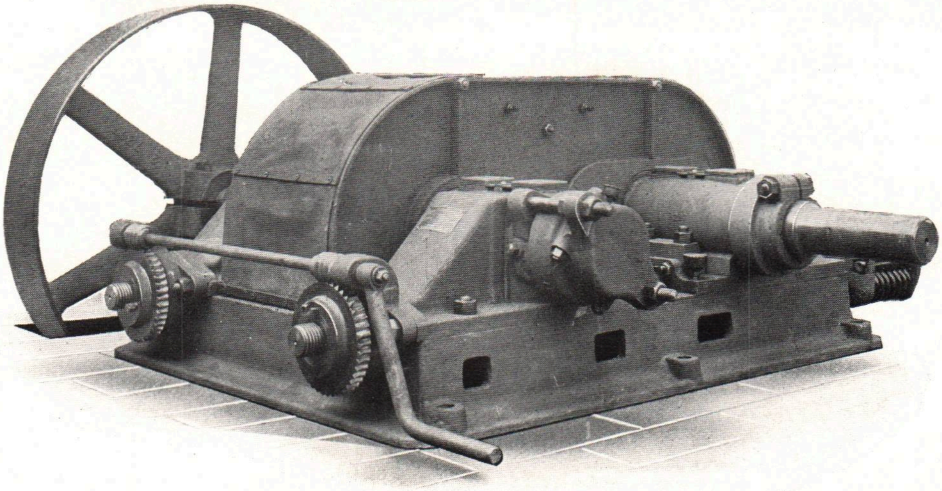


FIG. 856—36X16 CONVERTIBLE ROLLS SHOWING WORM NUT MECHANISM FOR ADJUSTING DISTANCE BETWEEN SHELLS

DETAILS OF CONSTRUCTION

MAIN FRAME

The frame is cast in one piece, broad and low, with large machine-finished surfaces on top for the bearing pedestals and housing and on the bottom for the foundation and attachment of discharge spout.

SHAFTS AND GRIT PROOF BEARINGS

The shafts are of the best forged mild steel, ample in diameter and, as shown in the cross section on page 7, have bearings of great length, as compared to the diameter of the shaft. The bearings in all rolls of our make are absolutely grit proof.

The centers are provided with flanges which extend through the housing and form a sleeve over the inner end of the bearing. Packing is inserted between this sleeve and the bearing and is held in place by a groove on the bearing, making an absolutely dust-proof joint.

Each bearing is a one-piece casting lined with renewable phosphor bronze bushing extending half way around the bearing and so located on the pressure side that ample lubrication is afforded by large spaces in the upper halves of the bearings, which are to be packed with oil-soaked woolen waste. Large handholes in the top of the bearings are fitted with weighted leather hinged covers.

The bushings of our bearings are made of phosphor bronze, turned inside and out, and are accurately fitted to machine fitted seats. They are held in position by bronze cap screws, and when worn out may be easily and quickly replaced by new ones which are exact duplicates, as all parts are made to standard gauge, saving much time over that required in the laborious process of babbitting. With this construction, our bearings are necessarily higher in first cost, but they are far cheaper in the course of several years' operation, owing to their greater durability, the longer life of shells due to better alignment of shafts and the time saved in renewal.

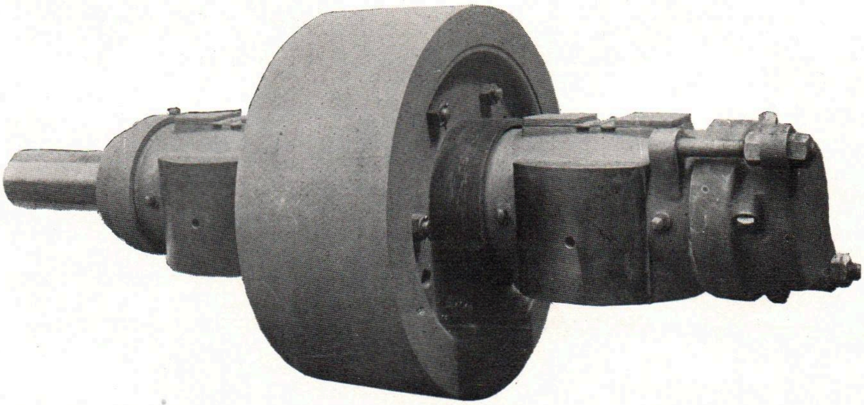


FIG. 862—SHELL, CENTER, SHAFT, BEARINGS, THRUST COLLAR AND DUST COLLAR, COMPLETE

Each bearing is mounted in a heavy cast-iron pedestal designed to permit the bearing to swivel in a horizontal plane. All bearing surfaces between the bearing and pedestal are machine finished. A lip is provided on top of the pedestal to prevent the bearing from rising. An adjustable take-up block is used to hold the bearing in place and affords quick and easy removal of the roll complete with its center, shaft, bearings and pulley.

The pedestals of the movable roll shaft bearing are free to move back and forth on renewable steel bearing strips attached to the top of the main frame by countersunk bolts.

The pedestals of the fixed roll bearings are securely bolted to the main frame.

The pedestals are designed to transmit the thrust from the bearings directly to the ends of the tension rods, which take all the crushing strains. The bearings and pedestals are so designed that the distance from the centers of the shafts to the top of the frame is as little as possible, thus decreasing any tendency to raise the bearings from the frame under the crushing strains.

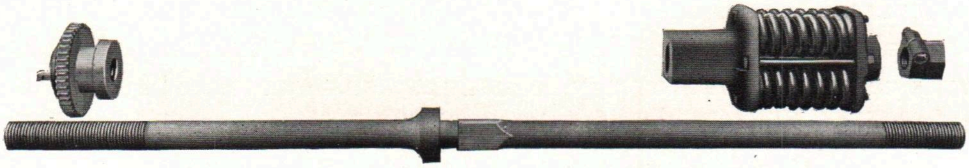


FIG. 861—TENSION ROD, WORM WHEEL NUT AND SPRINGS

TENSION RODS

The tension rods are of forged steel and so located that the vertical distance between tension rods and bearings is very short, thereby locating the tension rods as close as possible to the source of the stresses to which they are submitted. Each tension rod is forged with a collar against which the inner end of the movable pedestal rests. The outer end of this pedestal is in contact with a nest of springs (in the case of the spring rolls) or a safety block (in the case of the rigid rolls).

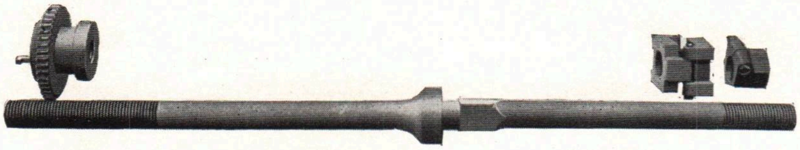


FIG. 860—TENSION ROD, WORM WHEEL NUT AND SAFETY BREAKING BLOCKS FOR RIGID ROLLS

The nest of springs or safety block in turn bears against a heavy nut screwed onto the end of the tension rod.

It will be seen that, in the case of the spring rolls, the spring tension is constant, irrespective of the distance between the roll shells.

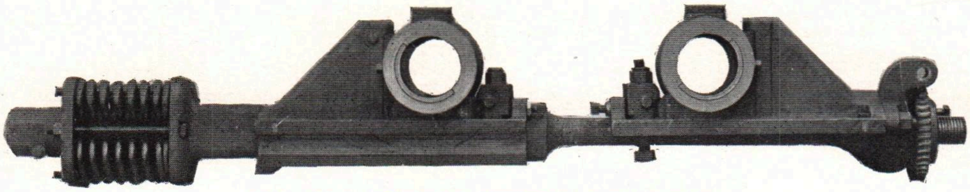


FIG. 864—TENSION SYSTEM, COMPLETE

The other end of each tension rod is fitted with a heavy steel nut bearing upon the outer end of the fixed bearing pedestal. Each of these steel nuts is fitted with a worm wheel with cut teeth. These worm wheels mesh with worms keyed on a transverse shaft, which is in turn fitted with a hand crank. By means of this crank, the worm wheel may be revolved in either direction and will in turn revolve the worm gears and adjusting nuts, thereby moving the tension rods and consequently the movable roll, in the desired direction. This adjustment of the distance between the rolls can be made while the rolls are running, and does not change the spring tension.

ROLL CENTERS

Two kinds are made by us, both having their advantages: The solid center with wooden and iron wedges, and the two-piece, double-cone, clamping center.

The solid center is rough turned on the outside to a diameter slightly smaller than the inside of the shell. The shells are rough turned on the inside, and have no taper. Wooden and iron wedges driven in between the center and the shell is the only fastening used. With this construction, both the center and the shells are cheaper.

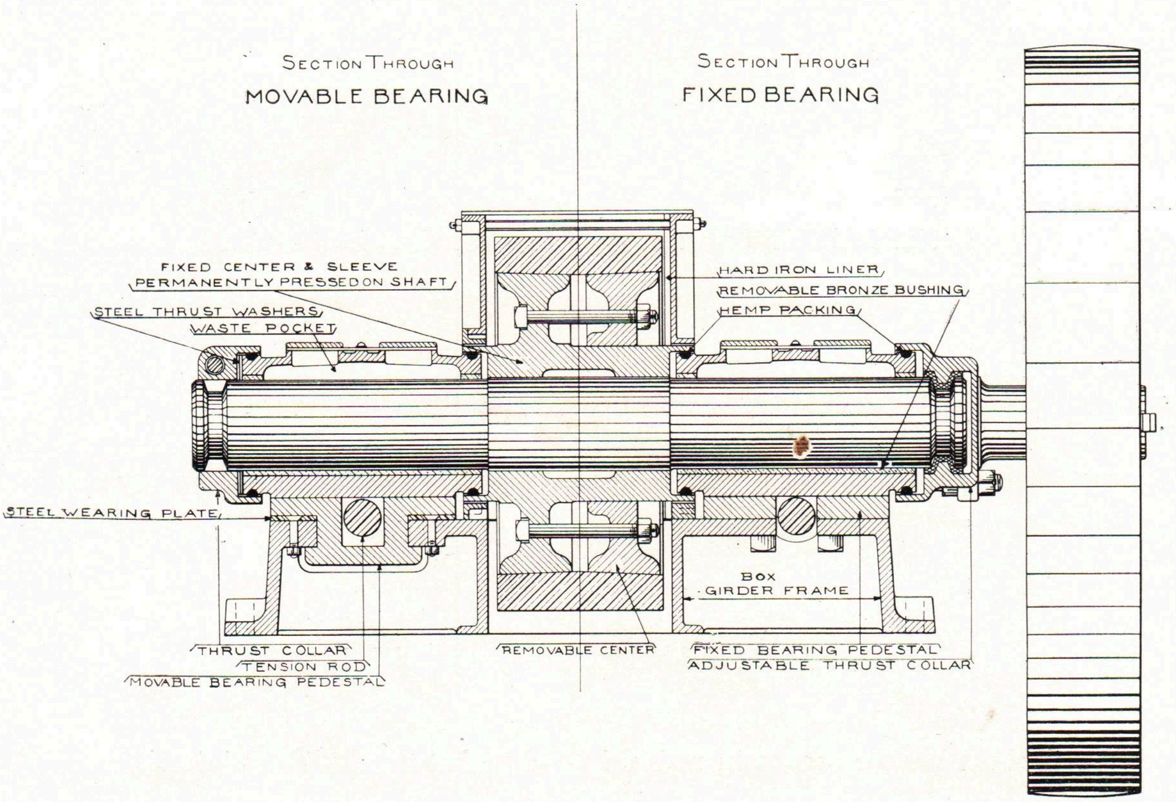


FIG. 0220—SECTION OF CONVERTIBLE ROLLS SHOWING DETAILS OF CONSTRUCTION OF BEARINGS, CENTERS, PEDESTALS, SHAFT, FRAME, ETC.

Our new two-piece center is an improvement over the form commonly used, namely, two narrow disks, each of which is mounted directly on the shaft, the bearing surface on the shaft being one-half of the width of the shell. With these narrow centers it is necessary to key both centers to the shaft in order to transmit sufficient power to the shells. After one center has been removed and replaced a few times, the hub of the removable center becomes enlarged, and when keyed on is forced to one side, thus: throwing the center out of true and causing the shell to "wobble" when running.

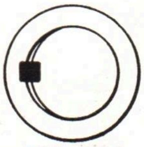


FIG. 034

With our improved centers this difficulty is obviated by the fixed center, which has a very long hub extending through the removable center and is forced on the shaft by heavy hydraulic pressure (See Fig. 0220, page 7). The length of this hub is considerably greater than the width of the shell, and has therefore ample bearing on the shaft for the transmission of the driving power to the shell through this one center. The removable center fits over the hub of the fixed center without being keyed thereto. It is split so that, in screwing it into the shell, it will contract and clamp tightly on the hub of the fixed center.

Two heavy bolts are provided as "backing off" bolts for the removable center, greatly facilitating the operation of changing shells.

SHELLS

Shells are made of the best and toughest forged steel. With shells having a double taper, less material is thrown away when the shell is worn out, than with the single tapered shells.

LATERAL ADJUSTMENT

The fixed roll shaft has a deep groove turned at one end in which a babbitted thrust bearing is fitted. This thrust bearing may be moved either inwardly or outwardly by means of two bolts, thus affording lateral adjustment of the fixed roll. This adjustment can also be made without shutting down the rolls.

This thrust bearing is combined with a dust-proof collar, and its end is closed so that no dust can possibly get into the thrust bearing which is made in halves that it may be readily removed.

Each shaft has the groove turned in its end so that the shafts are interchangeable.

Springs, when furnished, are of sufficient strength to give a pressure of 2 tons per inch of roll face.

HOUSING

Our rolls are provided with a dust-proof housing, which is easily detached. The sides are made of cast-iron and weighted canvas doors are fitted over the ends. The plates that cover the hole for the movable roll shaft and move with it are held in place and also prevented from rattling by springs. This is a refinement of design not usually found in rolls.

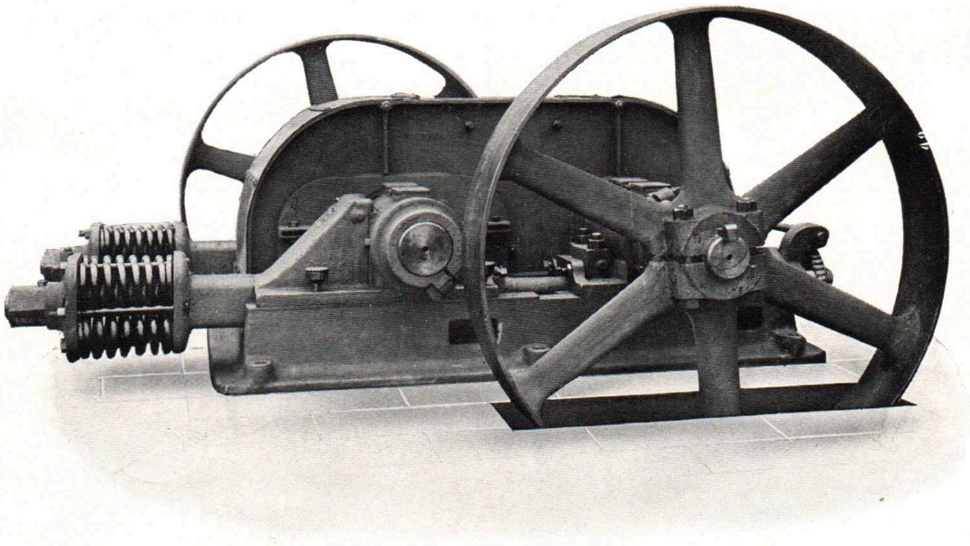


FIG. 857—30 X 14—CONVERTIBLE ROLLS, WITH SPRINGS

DRIVING PULLEYS

A pulley is furnished for each shaft. The pulleys are made heavy to give the necessary fly-wheel effect, and hubs are split to relieve the internal strains of the casting and to permit easy removal of pulleys.

It is generally a very difficult matter to obtain from stock line shaft pulleys of the exact diameters required to give the desired equal speed to both roll shafts when the roll pulleys are of unequal diameter. For this reason we equip our rolls with pulleys of the same diameter in order that both shells may be driven at *absolutely* the same peripheral speed to prevent sliming.

SAFETY DEVICE

(Used on rigid rolls only.) To prevent a possible damage to rolls or pulleys, by uncrushable material in the ore feed, we insert a pair of cast-iron blocks between the pedestal of each bearing and the retaining nut on the end of the tension rod. These blocks have holes drilled in them, through which two bolts of correct diameter are inserted so that they will shear as soon as the safe limit of crushing pressure is reached. This allows the movable roll to back off approximately two inches. It is a very simple matter to replace these shearing bolts, as they are of a common standard size.

FEEDERS

Feeders for our rolls are designed to be driven from the line shaft that drives the rolls.

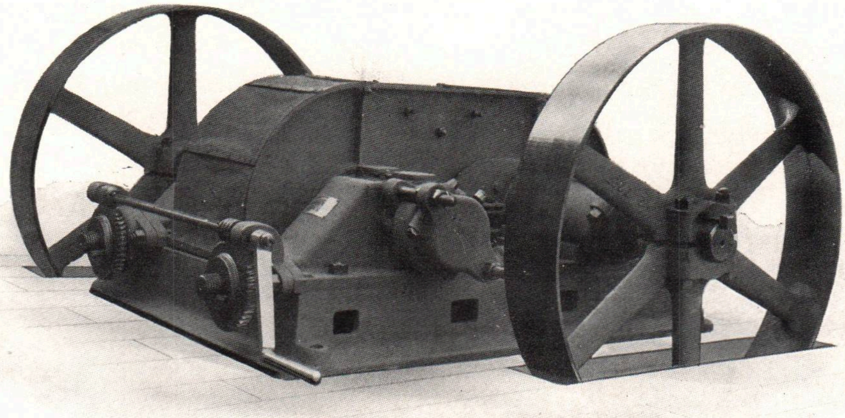


FIG. 878—30 X 14—CONVERTIBLE ROLLS. RIGID BEARINGS. NO SPRINGS

ADVANTAGES OF RIGID ROLLS

Rigid Rolls were first advocated and put on the market by the Denver Engineering Works. It has taken a number of years for the advantages of Rigid Rolls to become known, but to-day Rigid Rolls may be found in almost every Roll Crushing Plant.

Our Rigid Rolls are a radical departure from the old spring type, and a marked improvement over former practice. They are, as the name implies, without springs, and also without the attendant complications.

Rigid Rolls are positive in action, producing less slimes than Spring Rolls and practically no oversize. No oversize means no screening, no re-elevating and no recrushing.

Rigid Rolls operate without the jar or vibration found in spring rolls.

Roll shells require less attention and last longer on Rigid Rolls. ''Flanging'' occurs less.

This roll is designed so that a rigid type may be converted into a spring type by the addition of a spring and to permit a mill to have both types and yet have absolutely interchangeable parts.

Spring Rolls are used for coarse crushing where pick points, gads or other foreign substances are liable to be in the feeds.

Rigid Rolls are used to most excellent advantage for recrushing jig or table middlings or tailings.

HOW TO SELECT THE PROPER SIZE OF ROLLS

FIRST There must be known the size of the feed. From this the minimum diameter of Rolls is determined by referring to Diagram No. 0227. The size of feed is seldom over 1½ to 2 inches. If the pieces of ore are too large, they will not be caught or nipped by the shells, as the "angle of nip" is too great. The "angle of nip" is the angle formed by the tangents at the points where the particle of ore touches the shells. A, in Fig. 0230, page 13, is the angle of nip. For practical milling conditions, the maximum angle which may be used with safety is 31°. By increasing the distance between the shell the angle of nip is of course increased, but this decreases the percentage of reduction.

SECOND The speed, which depends on the diameter of the Rolls and the size of the feed, both the latter now known. Reference to Diagram No. 0227 gives the speed.

THIRD Size of finished product. The reduction in size of the feed particles as they pass through the Rolls must not exceed 4 to 1, if particles are ¼ inch or larger. This is equivalent to a reduction of 75 per cent. This means that 2-inch pieces must not be crushed in one stage to smaller than ½-inch, and if smaller product is desired, then the ½-inch product must be passed through a second set of Rolls, and so on. Further, it is not advisable to crush finer than 0.04 inch with any set of Rolls.

FOURTH Theoretical capacity, which depends on size of finished product and speed of Rolls. Both being known, reference to Diagram No. 0228 gives the result. The theoretical capacity is equal to the theoretical ribbon of material passing through the space between the two shells.

FIFTH Capacity Factor, which, multiplied by the theoretical capacity, gives the actual capacity. This factor depends on the percentage of reduction in size of the feed particles as they pass through the Rolls. One inch crushed to ¼-inch is 75 per cent. reduction. One inch crushed to ¾-inch is 25 per cent. reduction. Knowing the percentage of reduction, Diagram No. 0229 gives the Capacity Factor.

As crushed material is at least 50 per cent. void, then the actual maximum capacity to be expected from rolls would be 50 per cent. of the theoretical ribbon. This would be true when crushing soft rocks and with a uniform and continuous feed. For hard rocks 33 per cent. of the theoretical ribbon is correct, but in practice 30 per cent. is safer.

SIXTH Actual capacity, which is found by multiplying the theoretical capacity by the Capacity Factor.

For diagrams determining size and capacity of Rolls see page 13.

HOW TO USE THE DIAGRAMS TO DETERMINE THE PROPER SIZE AND SPEED OF ROLLS

Assume the maximum size of feed cube to be 1.6 inches. Find 1.6 (Diagram 0227) in the lower horizontal line of figures marked "Maximum size of particles in feed." Follow the vertical line corresponding with 1.6 until it intersects the curve of nip—31°. This point indicates a roll shell larger than 30 inches and smaller than 36 inches diameter. The 36-inch should therefore be used instead of the 30-inch shell. In the same manner the diagram gives the proper diameter of roll shell to use for each size of feed, as follows:

For feed 2.8 to 2 inches .... use 54-inch roll shells.
For feed 2. to 1.7 inches .... use 42-inch roll shells.
For feed 1.7 to 1.4 inches .... use 36-inch roll shells.
For feed 1.4 inches and smaller............ use 30-inch roll shells.

Next, the speed of the Rolls is to be determined:

Find the size of feed 1.6 (Diagram 0227) in the lower horizontal row of figures; follow the vertical line for this size upward until it intersects the curve for the 36-inch roll shell; then follow the horizontal line passing through this point to the figures on the left, giving 36 revolutions per minute as the proper speed.

Next to be determined is the theoretical capacity:

From Diagram No. 0228 find the revolutions 36 in the left-hand vertical column of figures, follow the corresponding horizontal line to the right until it intersects the diagonal line for 0.4 size of finished product; from this point of intersection, follow the vertical line down to the figures at the bottom of the diagram, and in the horizontal row corresponding to the 36-inch size of roll will be found 888 cubic feet per hour as the theoretical capacity.

Having assumed the size of finished product to be 0.4 inches:

Find 1.6 (Diagram 0229) in the vertical column for maximum size of *feed,* follow horizontal line to the right until it intersects the vertical line for 0.4 finished product. Follow the diagonal line to percentage of reduction, equals 75. From 75, percentage of reduction, drop down to the line A—B, and from the point of intersection follow the horizontal line to the right to "Amount of finished product in percentage of theoretical ribbon," 30 per cent. This means that, when crushing a feed cube of 1.6 inches down to 0.4 inch, the actual crushed product will be 30 per cent. of the theoretical ribbon.

The actual capacity will be the theoretical 888 multiplied by the capacity factor, 30 per cent., equals 266 cubic feet per hour.

For diagrams determining size and capacity of Rolls see page 13

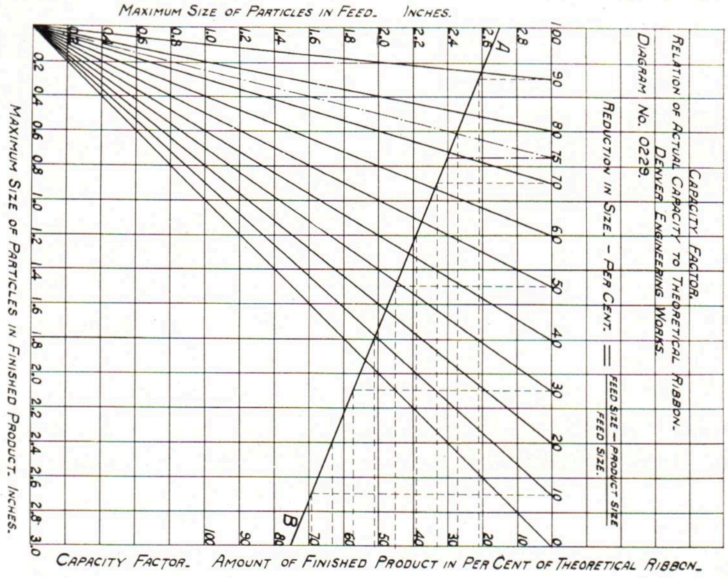


FIG. 0229

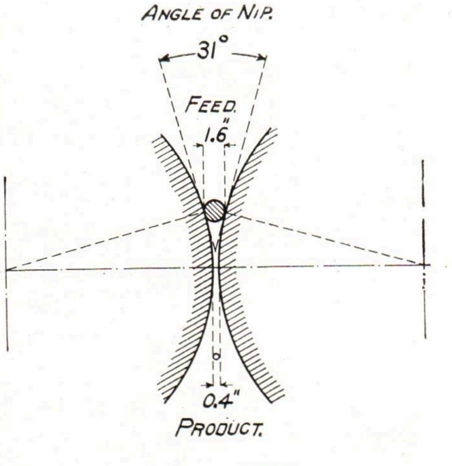


Figure 0230.

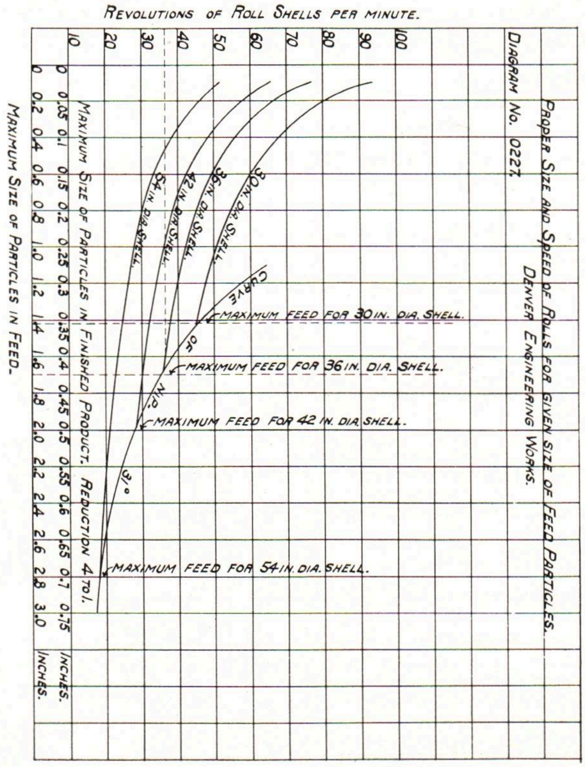


FIG. 0227

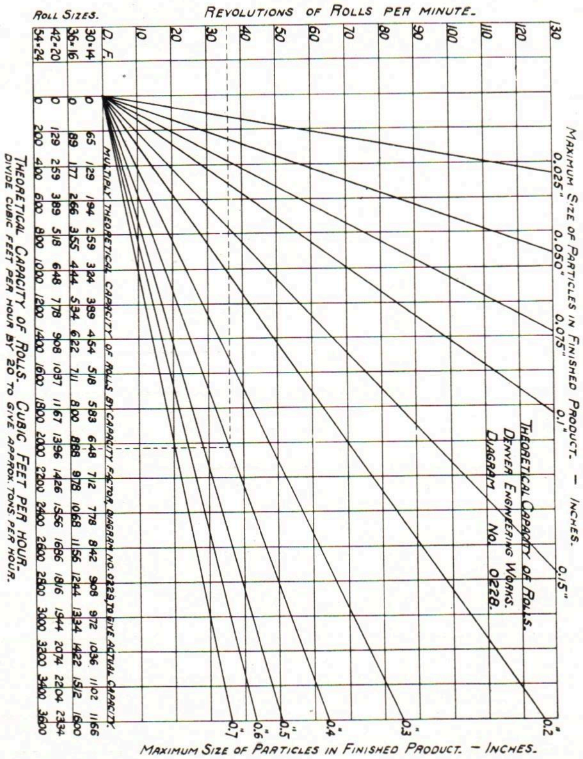
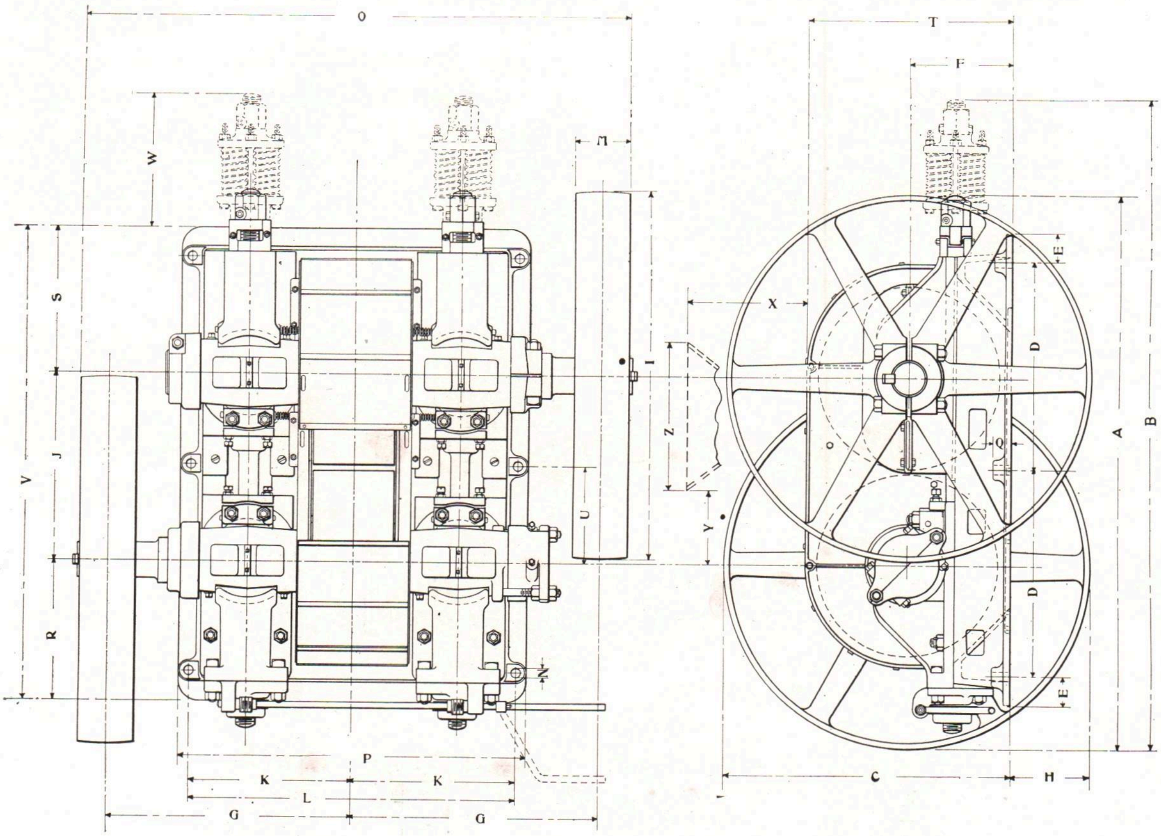


FIG. 0228

GENERAL DIMENSION DRAWING

CONVERTIBLE—1910 TYPE



DIMENSIONS OF CRUSHING ROLLS

CONVERTIBLE—1910 TYPE

DIMENSIONS IN FEET AND INCHES—APPROXIMATE ONLY

SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M
30x14	7-3	8-9	3-7	2-9	0-5	1-4	3-6	0-11	4-6	2-7	2-3	4-7	0-9
36x16	9-1	10-8	4-8	3-5	0-6	1-8	4-1	1-4	6-0	3-1	2-8	5-4	0-11
42x20	10-6	12-3	5-6	4-1	0-6	2-0	4-11	1-6	7-0	3-7	3-1	6-2	1-2
54x24	12-2	14-2	6-5	4-10	0-6	2-5	5-6	1-8	8-0	4-7	3-9	7-6	1-6

SIZE	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
30x14	0-1½	7-8	4-10	0-3	1-10	1-11	2-9	1-4	6-4	2-0	1-9	1-0	2-1
36x16	0-1¾	9-0	5-9	0-3½	2-4	2-5	3-4	1-7	7-9	2-3	2-0	1-5	2-5
42x20	0-1¾	11-0	6-6	0-4½	2-8	2-8	4-0	1-10	8-11	2-6	2-3	1-9	2-11
54x24	0-1¾	12-5	7-10	0-6	3-0	3-0	4-10	2-4	10-7	2-8	2-9	2-3	3-9

Below is a photograph of a few pieces which passed through a set of 14″ x 27″ rigid rolls without stopping or in any way damaging the rolls. Beside each crushed piece is a perfect piece for comparison.

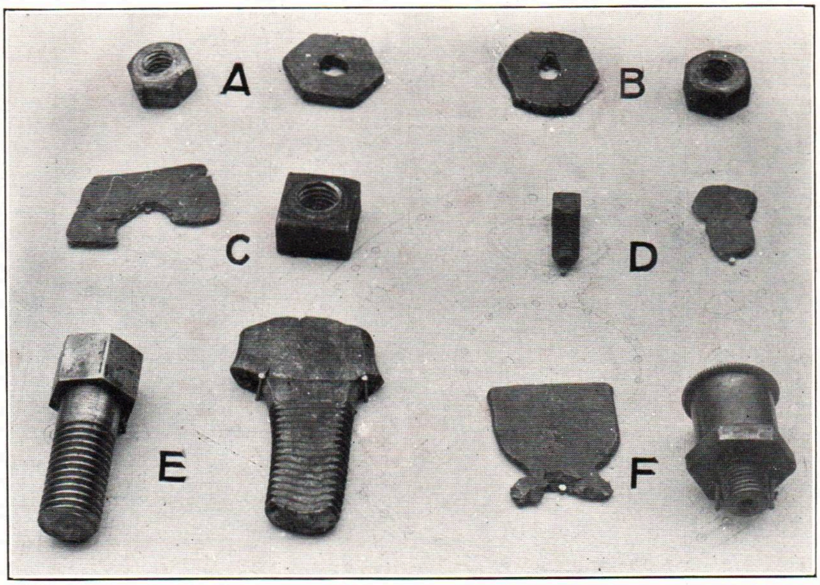
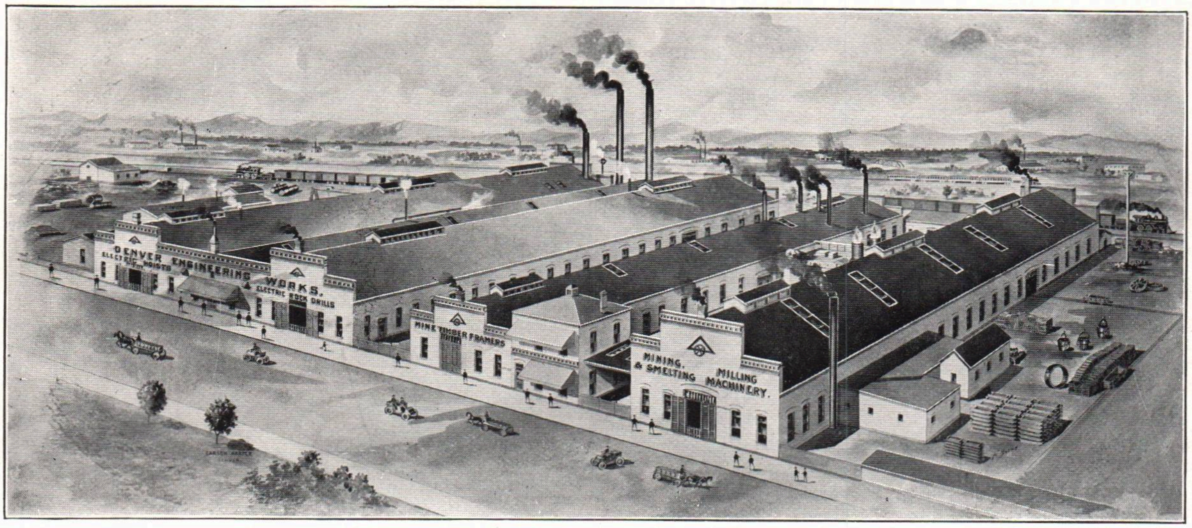


FIG. 0101

A.—$\frac{1}{2}$-inch hexagon steel nut.
B.—$\frac{1}{2}$-inch hexagon steel nut.
C.—$\frac{5}{8}$-inch square steel nut.
D.—$\frac{3}{8}$-inch by 1-inch case-hardened steel set screw.
E.—$\frac{3}{4}$-inch by $1\frac{3}{4}$-inch steel cap screw.
F.—1-inch diameter by $1\frac{3}{4}$-inch long brass grease cup.

DENVER ENGINEERING WORKS.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